



U.S. Department
of Transportation
Federal Highway
Administration



GEOSYNTHETIC REINFORCED SOIL INTEGRATED BRIDGE SYSTEM



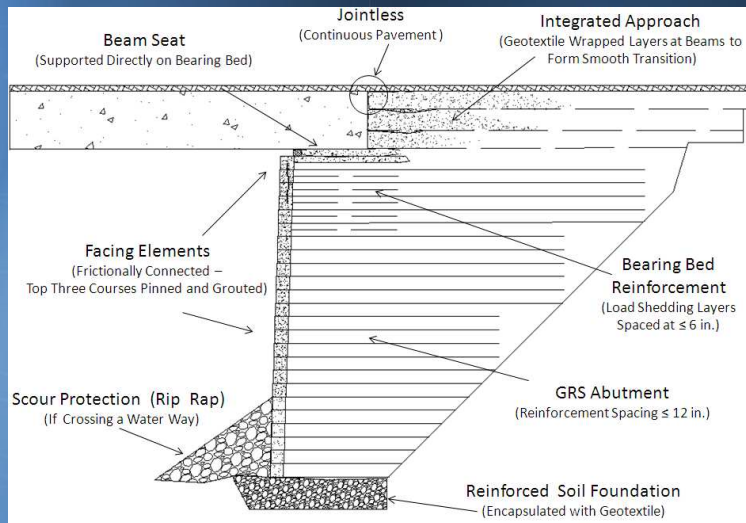
GRS Fundamentals

Definitions

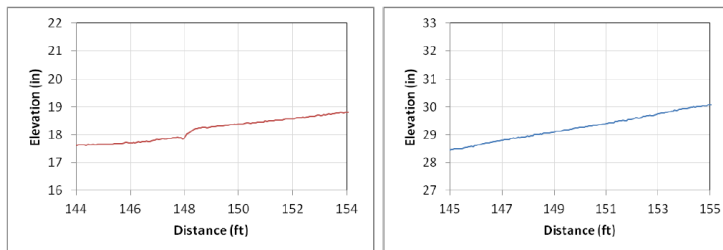
- **GRS - Geosynthetic Reinforced Soil**
 - An engineered fill of closely spaced ($< 12''$) alternating layers of compacted granular fill material and geosynthetic reinforcement
- **IBS - Integrated Bridge System**
 - A fast, cost-effective method of bridge support that blends the roadway into the superstructure using GRS technology



Cross-Section of GRS-IBS



IRI and road profile data



A)

B)

Figure 18. Surface profile for bridge joints a) on a bridge without GRS-Abutments (CR 27 Bridge Nr. 3340760) as compared to b) the GRS-Abutment at CR 27 Bridge Nr. 3340730



Fill Materials

#8 stone



Friction angle = 55°
Cohesion = 0 psf

A1a backfill



Friction angle = 53°
Cohesion = 0 psf



Reinforcement specs/properties/testing

Geogrids



Geotextiles



Facing Types



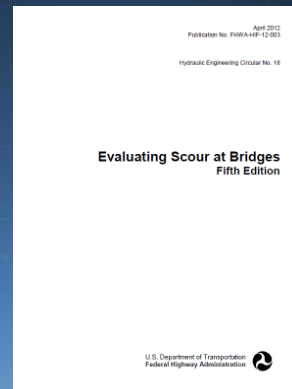
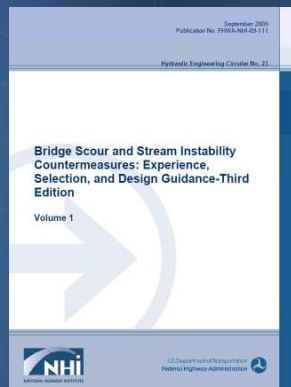
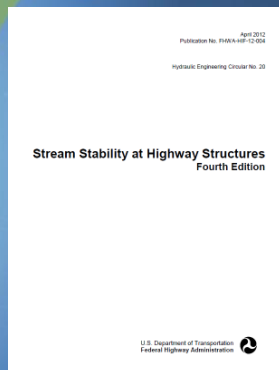


Supporting Technology Deployment Training and Technical Assistance

- Training as needed (face to face/webinars)
- Peer exchanges
- Demonstration showcases
- Technical assistance for design and construction
- Support of state and local agencies (consultants)
- Instrumentation and monitoring of new structures
- Development of references and design aids



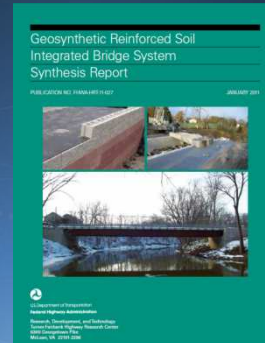
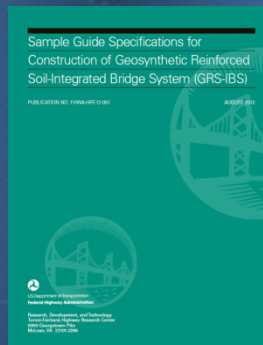
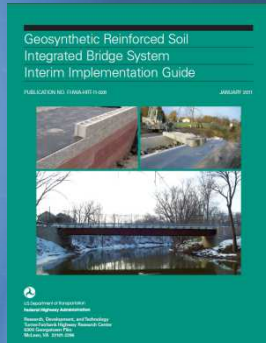
Hydraulic Engineering Circulars



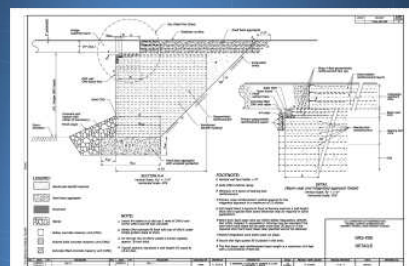
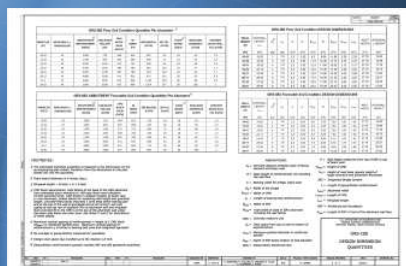
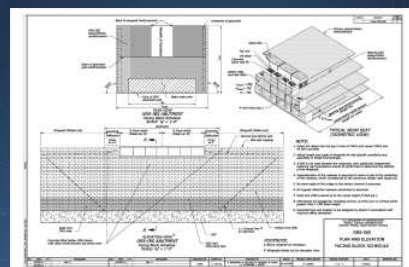
PDF version can be downloaded from the FHWA Hydraulics Web Page:
<http://www.fhwa.dot.gov/engineering/hydraulics/>
Under the publications section.



GRS Design and Construction Guidance



Standard Plans





Design Spread Sheet

LRFD			
1			
2	PERFORMANCE CRITERIA		
3	Tolerable Vertical Strain	ϵ_{vs}	0.5 %
4	Tolerable Lateral Strain	ϵ_{ls}	2 %
5			
6	LAYOUT		
7			
8	Span Length	L_{span}	70 ft
9	Wall Height	H	15.25 ft
10	Width of wall facing	B_{wall}	0.84 ft
11	Length of individual Wall Facing Element	L_{wall}	3.35 ft
12	Height of individual Wall Facing Element	H_{wall}	0.84 ft
13	Weight of individual Wall Facing Element	W_{wall}	44 lb
14	Number of Facing Elements in a Single Column	N_{wall}	24
15			
16	Base Width of Wall (including wall facing)	B_{base}	8 ft
17	Base Width of Wall (not including wall facing)	B	5.36 ft
18	Check Base to Height Ratio ≥ 0.3	B/H	0.35 OK
19			
20	Set Back (Section 4.3.4, FHWA-HRT-11-026)	S_b	12 in
21	Clear Space (Section 4.3.4, FHWA-HRT-11-026)	C_s	4 in
22			
23	Minimum Base Width of Reinforced Soil Foundation (Section 4.3.4, FHWA-HRT-11-026)	B_{min}	7.50 ft
24	Minimum Depth of Reinforced Soil Foundation (Section 4.3.4, FHWA-HRT-11-026)	D_{min}	1.3 ft
25	Minimum Distance of RSP in front of Abutment (Section 4.3.4, FHWA-HRT-11-026)	R_{min}	1.50 ft
26			
27	Reinforcement Spacing	S_r	8 in
28	Number of Reinforcement Layers	N_r	22
29	Secondary Reinforcement Spacing	S_{s2}	6 in
30			
31	SOIL AND REINFORCEMENT CONDITIONS		
32	Retained Soil Unit Weight	γ_s	125 lb/ft ³
33	Retained Soil Undrained Shear Strength	c_u	500 lb/ft ²
34	Retained Soil Effective Cohesion	c_e	500 lb/ft ²
35	Retained Soil Friction Angle	ϕ_s	38 deg
36	Active Earth Pressure Coefficient - Backfill	K_a	0.36
37			
38	Reinforced Fill Unit Weight	γ	110 lb/ft ³
39	Maximum Diameter of Reinforced Fill	d_{max}	0.5 in
40	Reinforced Fill Cohesion	c_r	0 lb/ft ²
41	Reinforced Fill Friction Angle	ϕ_r	48 deg
42	Active Earth Pressure Coefficient - Reinforced Fill	K_{ar}	0.15
43			
44	Decision	440	Required Reinf Strength - ASD

ASD			
1			
2	PERFORMANCE CRITERIA		
3	Tolerable Vertical Strain	ϵ_{vs}	0.5 %
4	Tolerable Lateral Strain	ϵ_{ls}	2 %
5			
6	LAYOUT		
7			
8	Span Length	L_{span}	70 ft
9	Wall Height	H	15.25 ft
10	Width of wall Facing Element	B_{wall}	0.84 ft
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13	Weight of individual Facing Element	W_{wall}	44 lb
14	Number of Facing Elements in a Single Column	N_{wall}	24
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16	Base Width of Wall (including wall facing)	B_{base}	8 ft
17	Base Width of Wall (not including wall facing)	B	5.36 ft
18	Check Base to Height Ratio ≥ 0.3	B/H	0.35 OK
19			
20	Set Back (Section 4.3.4, FHWA-HRT-11-026)	S_b	12 in
21	Clear Space (Section 4.3.4, FHWA-HRT-11-026)	C_s	4 in
22			
23	Minimum Base Width of Reinforced Soil Foundation (Section 4.3.4, FHWA-HRT-11-026)	B_{min}	7.50 ft
24	Minimum Depth of Reinforced Soil Foundation (Section 4.3.4, FHWA-HRT-11-026)	D_{min}	1.3 ft
25	Minimum Distance of RSP in front of Abutment (Section 4.3.4, FHWA-HRT-11-026)	R_{min}	1.50 ft
26			
27	Reinforcement Spacing	S_r	7.625 in
28	Number of Reinforcement Layers	N_r	34
29	Secondary Reinforcement Spacing	S_{s2}	3.8125 in
30			
31	SOIL AND REINFORCEMENT CONDITIONS		
32	Retained Soil Unit Weight	γ_s	125 lb/ft ³
33	Retained Soil Undrained Shear Strength	c_u	500 lb/ft ²
34	Retained Soil Effective Cohesion	c_e	0 lb/ft ²
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43			
44	Decision	ASD	Required Reinf Strength - ASD



YouTube Construction Video

Geosynthetic Reinforced Soil Integrated Bridge System

HIGHWAYS FOR LIFE

U.S. Department of Transportation
Federal Highway Administration

Geosynthetic Reinforced Soil-Integrated Bridge System (GRS-IBS)

FHWA USDOTFHWA - 128 videos

12,713

Subscribe 341

11 0



Performance Test Report

FHWA-HRT-13-066

Geosynthetic Reinforced Soil Performance Testing— Axial Load Deformation Relationships

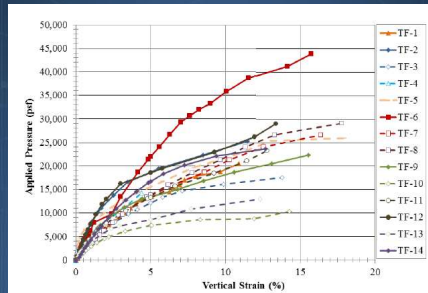
PUBLICATION NO. FHWA-HRT-13-066

AUGUST 2013



U.S. Department of Transportation
Federal Highway Administration

Research, Development, and Technology
Turner Fairbank Highway Research Center
1200 Georgetown Pike
McLean, VA 22101-2296



TECHBRIEF: FHWA-HRT-13-068

Friction Angles of Open-Graded Aggregates

TECHBRIEF



Friction Angles of Open-Graded Aggregates From Large-Scale Direct Shear Testing

FHWA Publication No.: FHWA-HRT-13-068
FHWA Contact: Jennifer Nicks, HRD-40, (202) 455-3075,
jennifer.nicks@dot.gov

Introduction

State and local transportation agencies frequently use open-graded aggregates for wall, roadway, and bridge construction. The primary advantages of using this type of material in wall and abutment applications are ease of constructability, lighter in-place density than well-graded materials, very low fine content, free-draining characteristics, and simpler quality assurance testing, using a method specification for field density. The American Association of State Highway and Transportation Officials (AASHTO) classifies open-graded aggregates according to the M43 gradation based on standard sizes for processed aggregates.¹ Despite common use of these aggregates, their strength characteristics have not been systematically measured or used in design. Instead, engineers frequently use a default friction angle of 34° leading to potential conservatism in retaining wall and foundation design. The primary purpose of this TechBrief is to present research results on the strength properties of standard open aggregates tested in a large-scale direct shear (LSDS) device to improve the state of practice for the design of structures using these materials.

Background

The most commonly used laboratory device available to measure the strength of aggregates are the direct shear (DS) and triaxial (TX) tests, with DS being the simplest and most regularly used test. Based on the American Association of Testing Materials (ASTM) standards, the maximum particle sizes for DS and TX testing are 1190 and 1180 of the width or diameter of the device, respectively. Standard DS devices are typically either circular, with a 2.5-inch diameter, or square, with 4-inch sides; therefore, the largest aggregates that can be tested are 0.25 or 0.4 inches, respectively. Similarly, standard TX devices are made for samples that are smaller than 2 inches in size; therefore, the maximum aggregate size that can be tested is about 0.3 inches. Because the AASHTO M43 aggregates are relatively large, with maximum aggregate size ranging from 0.375 to 4 inches, standard DS and TX devices are often not suitable.

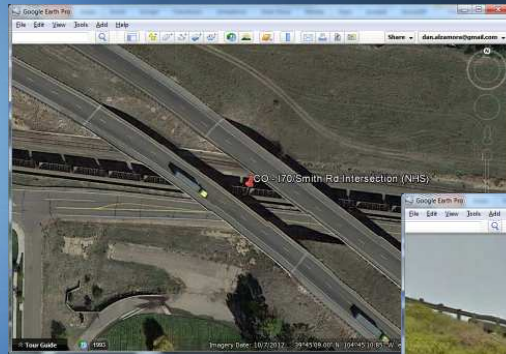


Table 2. Friction angle results using the linear MC envelope and ZDA approaches.

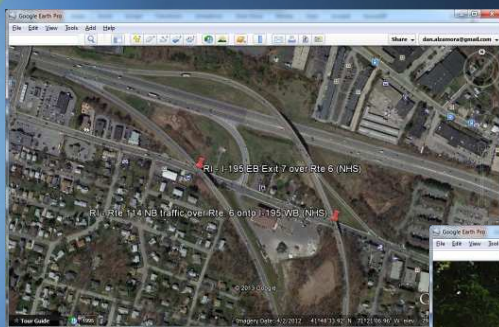
AASHTO Gradation	Friction Angle (°)			
	Mohr-Coulomb (MC)		Zero Dilatation Angle (ZDA)	
	Dry	Saturated	Dry	Saturated
5	51	59	52	49
56	59	57	53	56
57	52	56	47	56
6	59	60	50	54
67	55	60	53	57
68	50	52	51	51
7	57	52	54	52
78	53	48	51	49
8A	54	50	52	50
8B	47	45	50	50
8C	43	43	50	48
8D	52	46	53	50
89	47	45	48	49
9	53	45	52	48
10	46	41	46	44



CO, I-70 over Smith Rd



RI, I-195 Ramps Providence





OH – Bowman Rd Bridge



NY – CR 38 St. Lawrence County





WA - Sunday Creek



WI – SH40





IL – Great Western Trail over Grace ST



HI – Saddle Rd





ME - Knox County Beach Bridge



DE – Chesapeake City Road over Guthrie Run





MN – CR 55 over MN Southern Railway

